an electrical detection device, wherein the bias voltage source and the electrical detection device are coupled with the two electrodes.

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25. (New) The neutron detecting device of claim 22, wherein the first and second regions contain at least 80% ^{10}B.

<u>Remarks</u>

A reconsideration of the present application is respectfully requested. Claims 14-25 have been added. No claims have been amended or deleted. Therefore, claims 1-25 are currently pending in the present application.

Claims 2, 3 and 13 were rejected under 35 U.S.C. § 112, first paragraph, as based on a disclosure which is not enabling. It is clear that the specification of the above-referenced patent application demonstrates that the inventors intended that the principles of the present invention be implemented in the form of a homojunction diode. For example, the first sentence in the specification states that the invention applies to homojunction diodes. <u>See</u> <u>Specification</u>, page 4, lines 24-26. In addition, the specification also states that "[a]lthough the invention is described above as relating to heterojunction diodes, it will be understood that the invention can be implemented in a large number of other ways, including homojunction diodes . . . ." Page 9, lines 24-26. Moreover, claims 2, 3 and 13 themselves indicate that the Applicants were in possession of a sensing mechanism that is inherent in the boron carbide layer, and a neutron detection device that is a homojunction diode. <u>See</u> <u>In re Koller</u>, 613 F.2d 819, 204 USPQ 702 (CCPA 1980) (stating the original claims constitute their own description).

Given the fact that "[e]nablement is determined from the viewpoint of persons of skill in the field of the invention at the time the patent application was filed, a patent applicant need not include in the specification that which is already known to and available to the public." Ajinomoto Co. v. Archer-Daniels-Midland Co., 228 F.3d 1338, 56 USPQ.2d 1332 (Fed. Cir. 2000); Paperless Accounting, Inc. v. Bay Area Rapid Transit Sys., 840 F.2d 659, 231 USPQ 649 (Fed. Cir. 1986). Applicants submit that the formation of a nickel doped boron carbide homojunction diode was known and made available to the public at the time the above-referenced patent application was filed. See Seong-Don Hwang et al., *Fabrication of n-type nickel doped $B_5C_{1+\delta}$ homojunction and heterojunction diodes*, 70 APPLIED PHYSICS LETTER 1028 (1997) (this reference was provided in the Information Disclosure Statement dated May 25, 2001). In particular, the Seong-Don Hwang reference generally states that a nickel doped boron carbide ($Ni\text{-}B_5C_{1+\delta}$) may be combined with a p-type boron carbide (B_5C) to form a homojunction diode. See Spectra-Physics, Inc. v. Coherent, Inc., 827 F.2d 1524, 3 USPQ.2d 1737 (Fed. Cir. 1987) (stating that a patent need not teach, and preferably omits, what is well known in the art). Thus, a person skilled in the art could have utilized the Seong-Don Hwang reference to make or use a homojunction diode incorporating the principles of the present invention without undue experimentation.

Claims 2, 3 and 13 were also rejected under 35 U.S.C.§ 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. In support of this rejection, the Examiner asserts that "[c]laim 1 (from which claims 2 and 3 depend) does not, by itself, give a homojunction diode because the claim only recites a 'layer of boron carbide semiconductor.'" Final Office Action, page 3. However, the determination of whether a claim is indefinite "depends on whether those skilled in the art would understand the scope of the claim when the claim is read in light of the specification." Atmel Corp.

v. Information Storage Devices, Inc., 198 F.3d 1374, 53 USPQ.2d 1225 (Fed. Cir. 1999). Contrary to the Examiner's assertion set forth above, the description of a "layer of boron carbide semiconductor" in claim 1 does leave open the possibility that the neutron detecting device can be a homojunction diode. Specifically, claim 1 can be interpreted in such a way that the layer of boron carbide be divided into regions or sub-layers with varying degree of doping of varying types (i.e., p-type and n-type regions). As such, claim 1 may be interpreted as a homojunction diode by one skilled in the art, while at the same time using appropriate language to allow the device of the present invention to be claimed as a heterojunction diode.

The Examiner went on to note that claim 5 provides further evidence that claim 1 lacks a critical element because it is not possible for the same structure, as disclosed in claim 1, to be a homojunction and heterojunction diode. See Final Office Action, page 4. As can be seen in the application as filed, claim 5 depends from claim 4 and provides for a layer of silicon that communicates with the layer of boron carbide. Thus, while claim 5 standing alone with claim 1 may not provide the necessary elements for a heterojunction diode, the fact that a layer of silicon is introduced in claim 4 does in fact provide the elements necessary to form a heterojunction diode. In light of the comments set forth above, Applicants respectfully request that the rejection based upon 35 U.S.C. § 112, first and second paragraphs be withdrawn.

Claims 1, 4-7, 9, 11 and 12 have been rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 5,940,460 to Seidel et al. ("the Seidel reference"). Applicants respectfully traverse this rejection.

The law states that "[a] person shall be entitled to a patent unless the invention was patented or described in a printed publication in this or a foreign country or in a public use or on sale in this country, *more than one year prior to the date of application for patent* in the United States."

35 U.S.C. § 102(b). The priority date for the present patent application based upon U.S. Provisional Application Number 60/109,898 which was filed on November 25, 1998. In contrast, the Seidel reference was published *after* the priority date of the present application on August 17, 1999. Since the Seidel reference was not published more than one year prior to the date of the effective filing date of the present application, the rejection based upon § 102(b) is inappropriate and should be withdrawn.

In the alternative, if the Examiner finds other grounds for rejecting claims 1, 4-7, 9, 11 and 12 based upon the Seidel reference, Applicants also traverse this rejection. In general, the Seidel reference provides for a solid state neutron detector array where each detector includes a substrate 12, a semiconductor active region 14, 16, a conductive contact 18, and a neutron converter layer 22.

The invention of claim 1 relates to a neutron detector device having a sensing mechanism with a layer of boron carbide semiconductor that is an electrically active part of the detection device. The neutron detector device also includes a monitoring device that records the changes in the boron carbide layer detected by the sensing mechanism. By providing a construction in accordance with claim 1, numerous advantages are realized. For example, the use of semiconducting boron carbide allows for the capturing of neutrons and the generation of measurable electrical signals that results in efficient ionization and sweeping out of electrical charge to detect for the presence of neutrons. See Specification, page 5, lines 7-12, 18-24; page 8, line 30; page 9, lines 1-7.

None of the references of record either, when considered singly or in combination with one another, teach or suggest a neutron detecting device having a layer of boron carbide semiconductor as recited in claim 1. The Seidel reference states that the semiconducting regions of

the neutron detector 10 include the substrate 12, the n-type semiconducting layer 14 and the p-type semiconducting layer 16. See Seidel reference, Col. 3, lines 55, 66-67; Col. 4, lines 1-3. In particular, the Seidel reference states that the substrate 12 is formed of SiC, GaAs, CdTe, diamond, Ge or Si. See Col. 3, lines 55-56. Further, the Seidel goes on to state that the p-type and n-type semiconducting layers 14, 16 are formed of Si, Ge, SiC, diamond, GaAs, GaP, PbO and CdS. See Col. 4, lines 3-4, 8. Therefore, it is clear that none of the semiconducting materials in the Seidel reference are formed of semiconducting boron carbide, thus failing to teach every limitation included in claim 1 of the present application. See Apple Computer, Inc. v. Articulate Systems, Inc., 234 F.3d 14, 57 USPQ.2d 1057 (Fed. Cir. 2000) (stating that the prior art must teach each and every limitation in order to anticipate the claimed invention).

In rejecting claim 1, the Examiner contends that the neutron converter layer 22 in the Seidel reference is the equivalent of the layer of boron carbide semiconductor as recited in claim 1. See Final Office Action, page 5. However, it is the Applicants position that the semiconducting boron carbide layer in claim 1 is not equivalent to the neutron conversion layer in the Seidel reference. In order to appreciate the distinction between the present invention and the Seidel reference, one must understand that conversion layers are inherently different and inferior compared to the semiconducting regions in the present neutron detection device. See Specification, page 2, lines 20-23; page 9, lines 8-14.

It is generally known by one skilled in the art that a conversion layer provides for a 1) neutron capturing region that provides capture products (i.e., ^{4}He and ^{7}Li) that can be detected; and 2) an electrical signal generation region that generates an electrical signal through the interaction of the capture products whereby the neutron capturing region and electrical signal generation region are separate and distinct from one another. One reason the conversion layer is different from the present

invention is because there are portions of the neutron capture region where neutrons are captured but do not yield any capture products that can reach the electrical signal generation region. The reason for this is because the range of the reaction products is too short for the electrical signal generation region to efficiently generate an electrical signal for all of the reaction products produced in the neutron capture region. In contrast, the layer of semiconducting boron carbide included in the present invention includes a neutron capturing region and an electrical signal generating region that are generally one in the same. As such, the neutron detector of the present invention is able to achieve a high efficiency because the reaction of ^{10}B with neutrons results in ions which very efficiently ionize atoms in the surrounding electrically active semiconductor where the charge can be swept out efficiently. See Specification, page 8, line 30; page 9, lines 1-3. Moreover, the neutron conversion layer in the Seidel reference is physically separated from the semiconducting layers 14, 16 further emphasizing the fundamental differences between the structure of neutron converter layer in the Seidel reference and the layer of boron carbide semiconductor material as set forth in claim 1.

Furthermore, none of the references of record either, when considered singly or in combination with one another, teach or suggest a neutron detecting device having a layer of boron carbide semiconductor that is an electrically active part of the device as recited in claim 1. In rejecting claim 1, the Examiner stated that "electrically active part" was not defined in the disclosure and subsequently interpreted the term as "having an active part in the production of electrical pulses from the detector." Final Office Action, page 2. To the contrary, the specification of the present application does define the term "electrically active." Specifically, the specification of the present invention states that being electrically active is when the lithium ion and the alpha particle cause dense ionization of other atoms, electron-hole pairs are created by the ionization of the atoms, and the electric fields applied across the boron carbide layer then sweep out a large fraction of the

electron-hole pairs. See Specification, page 8, lines 25-29; see also page 3, line 13 (stating the boron carbide semiconductor uses its electrical properties as a semiconductor rather than its electrical property of resistance).

Additionally, the "electrically active" function of a semiconductor in a semiconductor device is very different than the "electrically active" function of the neutron converter layer as used in the Seidel reference. In particular, the Seidel reference states that the neutron converter layer 22 may be directly deposited on the semiconductor active regions 14, 16 as an electrical contact in place of contact 18. Therefore, the neutron conversion layer may serve as a "contact" for the semiconducting active regions in the Seidel reference, but does not, itself, comprise an electrically active semiconductor region. "Electrically active" is not a proper term to use with reference to a contact. A contact is able to provide electrical control of something else. It can conduct charge and exhibit electrical resistance. However, the neutron conversion layer contact does not produce an electrical signal by virtue of collection of charge liberated within the neutron conversion layer contact – the liberated charge is not able to be collected to any appreciable extent. In contrast, the present invention is able to collect liberated charge from a neutron capture and does produce an electrical signal, thus allowing for the detection of a neutron capture, which is one of the advantages of the present invention.

The Examiner also states that the neutron converter layer of the present invention generates the charged particles (from neutron interactions) that create pulses from the detector. See Final Office Action, page 2. This is only true in the case of charged particles that are able to escape from the converter layer. If the neutron converter layer is thick enough to capture a large fraction of the incident neutrons, it will be thicker than the range of "charged particles (from neutron interactions)" and the particles will not reach the regions of the detector in which the charge pulse

can be created. This is the source of the inefficiency of detection of neutrons with the detection device in the Seidel reference and with all conversion layer devices. See Specification, page 2, lines 20-23, page 9, lines 8-14.

Since none of the references to teach or suggest all of the limitations in independent claim 1, Applicants respectfully request withdrawal of the rejection of claim 1 for at least the above referenced reasons. As claims 4-7, 9 and 11 depend either directly or indirectly from claim 1, these claims are believed to be in condition for allowance for at least the above cited reasons. As such, Applicants respectfully request withdrawal of the rejection of claims 4-7, 9 and 11 as well.

Dependent claims 4-7, 9 and 11 recite additional features of the inventive construction and are further distinguishable from the references of record. For example, claim 11 provides the neutron detecting device of the present invention that is capable of operating at 500 °C. While the Seidel reference states that the semiconducting active regions 14, 16 are preferably made of materials capable of operating at temperatures above 100 °C, it is not apparent and not specifically disclosed how the Seidel device could operate at temperatures above 500 °C. Therefore, Applicants request that the rejection of claim 11 be withdrawn for this additional reason.

Independent claim 12 provides for a method for detecting neutrons which includes 1) positioning a neutron detecting device in a location to allow the device to intercept a stream of neutrons, the detector comprising a layer of boron carbide that is an electrically active part of the device and a sensing mechanism coupled to the boron carbide layer, 2) introducing at least one neutron traveling in a direction to be intercepted by the boron carbide layer, and 3) monitoring the interaction of the neutron with the boron carbide semiconductor where the sensing mechanism detects changes in the boron carbide layer caused by the interception of neutrons.

None of the references of record either, when considered singly or in combination with one another, show or suggest a method that includes monitoring the interaction of the neutron with the boron carbide semiconductor where the sensing mechanism detects changes in the boron carbide layer caused by the interception of neutrons as recited in claim 12. The relevant arguments that were set forth with regard to claim 1 are equally applicable to the allowability of claim 12. In particular, the range of the reaction products in the Seidel reference is too short for the electrical signal generation region to efficiently generate an electrical signal for all of the reaction products produced in the neutron capture region. The layer of semiconducting boron carbide included in the present invention includes a neutron capturing region and an electrical signal generating region that are generally one and in the same. The neutron detector of the present invention is able to achieve a high efficiency because the reaction of ^{10}B with neutrons results in ions which very efficiently ionize atoms in the surrounding electrically active semiconductor where the charge can be swept out efficiently. Since none of the references of record teach or suggest all of the limitations in independent claim 12, Applicants respectfully request withdrawal of the rejection of claim 12 for at least the above references reasons.

Further, claims 8 and 10 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over the Seidel reference. None of the references of record teach or suggest at least two diodes interleaved with a neutron energy absorber as recited in claim 8. The Examiner rejected claim 8 by stating that it is conventional application in the nuclear spectrometry art wherein two semiconductor detectors are used in combination with a coincidence circuit for purposes of eliminating background. See Final Office Action, page 6. The specification of the present invention is directed to assessing neutron energy distributions (i.e., neutron calorimetry), not increasing detection efficiency or coincidence background elimination. In fact, coincidence operation to

eliminate background is rendered much less necessary because of the low atomic number and thin nature of the device of the present invention. Thus, Applicants requests that the rejection of claim 8 be withdrawn.

Further, claim 10 provides for a boron carbide layer that contains at least 80% ^{10}B. The Seidel reference does not teach or suggest the amount of enrichment of the neutron converter layer, and certainly does not suggest enrichment of at least 80%. Given the absence of prior art that substantiates that at least 80% ^{10}B enrichment is well known in the art, Applicants submit that the rejection of claim 11 has been reasonably traversed and request that the rejection of claim 10 be withdrawn.

Claims 14-21 are directed to a neutron detecting device including a semiconducting boron carbide layer and a substrate layer. The substrate layer is coupled with the semiconducting boron carbide layer and the semiconducting boron carbide layer is an electrically active region of the detecting device. Claims 22-25 are directed to a neutron detecting device including first and second regions. The first region is formed of p-type semiconducting boron carbide and the second region formed of n-type semiconducting boron carbide. In addition, the first and second regions are electrically active parts of the detecting device. Applicants submit that claims 14-25 contain patentable subject matter and are allowable over the references of record.

Conclusion

Applicants respectfully submit that claims 1-25 are patentable over the references of record and ask that the application be placed in condition for allowance. Should the Examiner believe any issues are outstanding, the Examiner is encouraged to call the undersigned at (816) 474-6550.

The present Response is being filed concurrently with 1) a petition for a three-month extension of time; 2) a Request for Continued Examination; and 3) a check in the amount of $969.00, which covers the $465.00 fee for the three-month extension of time, the $375.00 fee for the Request for Continued Examination, and the $129.00 fee for the additional claims added to the patent application. The Commissioner is hereby authorized to charge any additional fees that are required, or credit any overpayment, to Deposit Account No. 19-2112.

Respectfully submitted,

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